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RADIO TEST REPORT

FCC 47 CFR PART 15 SUBPART E

INDUSTRY CANADA RSS-247

Test Standard	FCC Part 15.407+ RSS-247 issue 2 and RSS-GEN issue 5
Brand name	muRata
Product name	Communication Module
Model No.	LBEE5QD1ZM
Test Result	Pass
Statements of Conformity	Determination of compliance is based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.

The test Result was tested by Compliance Certification Services Inc. The test data, data evaluation, test procedures, and equipment configurations shown in this report were given in ANSI C63.10: 2013 and compliance standards.

The test results of this report relate only to the tested sample (EUT) identified in this report.

The test Report of full or partial shall not copy. Without written approval of Compliance Certification Services Inc.(Wugu Laboratory)

Approved by:



Kevin Tsai
Deputy Manager

Unless otherwise stated the results shown in this test report refer only to the sample(s) tested and such sample(s) are retained for 90 days only.

除非另有說明，此報告結果僅對測試之樣品負責，同時此樣品僅保留90天。本報告未經本公司書面許可，不可部份複製。

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Revision History

Rev.	Issue Date	Revisions	Effect Page	Revised By
00	December 11, 2020	Initial Issue	ALL	Mita Wu



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1. GENERAL INFORMATION

1.1 EUT INFORMATION

Applicant	Murata Manufacturing Co., Ltd. 1-10-1, Higashikotari, Nagaokakyo-shi, Kyoto 617-8555 Japan
Manufacturer	Murata Manufacturing Co., Ltd. 1-10-1, Higashikotari, Nagaokakyo-shi, Kyoto 617-8555 Japan
Equipment	Communication Module
Model No.	LBEE5QD1ZM
Model Discrepancy	N/A
Trade Name	muRata
Received Date	September 15, 2020
Date of Test	September 28, 2020
Power Supply	Power from Power supply.
HW Version	1.0
SW Version	1.0
EUT Serial #	Adaptivity/Receiver Blocking/DFS : NO.5

Remark:

1. For more details, please refer to the User's manual and Operation description of the EUT.
2. Disclaimer: Antenna information is provided by the applicant, test results of this report are applicable to the sample EUT received.

1.2 EUT CHANNEL INFORMATION

Frequency Range			
		Mode	Frequency Range (MHz)
	UNII-2A	IEEE 802.11a	5260 ~ 5320
		IEEE 802.11n HT 20 MHz	5260 ~ 5320
		IEEE 802.11n HT 40 MHz	5270 ~ 5310
		IEEE 802.11n HT ac20 MHz	5260 ~ 5320
		IEEE 802.11n HT ac40 MHz	5270 ~ 5310
		IEEE 802.11ac VHT 80 MHz	5290
	UNII-2C	IEEE 802.11a	5500 ~ 5720
		IEEE 802.11n HT 20 MHz	5500 ~ 5720
		IEEE 802.11n HT 40 MHz	5510 ~ 5710
		IEEE 802.11n HT ac20 MHz	5500 ~ 5720
		IEEE 802.11n HT ac40 MHz	5510 ~ 5710
		IEEE 802.11ac VHT 80 MHz	5530, 5610, 5690
Modulation Type	OFDM (QPSK, BPSK, 16-QAM, 64-QAM, 256-QAM)		

Remark:

1. Refer as ANSI C63.10: 2013 clause 5.6.1 Table 4 for test channels
2. For Canada the EUT Frequency Range 5600~5720MHz will be disabled.

Number of frequencies to be tested		
Frequency range in which device operates	Number of frequencies	Location in frequency range of operation
☐ 1 MHz or less	1	Middle
☐ 1 MHz to 10 MHz	2	1 near top and 1 near bottom
☒ More than 10 MHz	3	1 near top, 1 near middle, and 1 near bottom

1.3 ANTENNA INFORMATION

Antenna Specification	No	Maker	P/N	Ant. Type	Gain (dBi)
	1	Molex	146153	dipole	4.25
	2	Molex	146187	dipole	4.75
	3	Murata	LBEE5QD1ZM-Antenna	Monopole (PCB)	4.6
Antenna Connector	N/A				

1.4 MEASUREMENT UNCERTAINTY

PARAMETER	UNCERTAINTY
3M Semi Anechoic Chamber / 30MHz ~ 1GHz	+/-3.7046
3M Semi Anechoic Chamber / Above 1GHz	+/-3.0958

Remark: This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

1.5 FACILITIES AND TEST LOCATION

All measurement facilities used to collect the measurement data are located at

No.11, Wugong 6th Rd., Wugu Dist., New Taipei City, Taiwan. (R.O.C.)

Remark: The sites are constructed in conformance with the requirements of ANSI C63.7, ANSI C63.4 and CISPR Publication 22.

1.6 INSTRUMENT CALIBRATION

Dynamic Frequency Selection					
Name of Equipment	Manufacturer	Model	Serial Number	Calibration Date	Calibration Due
Attenuator	E-INSTRUMENT	EPA-600H	EC1400050	07/20/2020	07/19/2021
Coaxial Cable	Woken	WC12	DC004	06/29/2020	06/28/2021
Power Divider	Solvang Technology	STI08-0015	008	08/05/2020	08/04/2021
Spectrum Analyzer	R&S	FSU 26	100258	06/12/2020	06/11/2021
Vector Signal Generator	R&S	SMU 200A	101480	04/27/2020	04/26/2021
Vector Signal Genertor	R&S	SMU 200A	103439	04/21/2020	04/20/2021
Software	GPIBShot,DFS-Aggregate-Time FSU,R&S Pulse Sequencer DFS				

Remark: Each piece of equipment is scheduled for calibration once a year.

1.7 SUPPORT AND EUT ACCESSORIES EQUIPMENT

EUT Accessories Equipment					
No.	Equipment	Brand	Model	Series No.	FCC ID
	N/A				

Support Equipment					
No.	Equipment	Brand	Model	Series No.	FCC ID
	N/A				

1.8 TEST METHODOLOGY AND APPLIED STANDARDS

The test methodology, setups and results comply with all requirements in accordance with ANSI C63.10:2013, KDB 789033 D02, KDB 905462 D02, RSS-247 Issue 2 and RSS-GEN Issue 5.



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2. TEST SUMMARY

FCC Standard Sec.	IC Standard Sec.	Chapter	Test Item	Result
15.203	-	1.3	Antenna Requirement	Pass
15.407(h)	RSS-247(6.3)	4.1	Dynamic Frequency Selection	Pass

3. DESCRIPTION OF TEST MODES

3.1 THE WORST MODE OF OPERATING CONDITION

Operating Frequency Range & Number of Channels			
	Mode	Frequency Range (MHz)	Number of Channels
	UNII-2A	IEEE 802.11a	5260 ~ 5320
		IEEE 802.11n HT 20 MHz	5260 ~ 5320
		IEEE 802.11n HT 40 MHz	5270 ~ 5310
		IEEE 802.11n HT ac20 MHz	5260 ~ 5320
		IEEE 802.11n HT ac40 MHz	5270 ~ 5310
		IEEE 802.11ac VHT 80 MHz	5290
	UNII-2C	IEEE 802.11a	5500 ~ 5720
		IEEE 802.11n HT 20 MHz	5500 ~ 5720
		IEEE 802.11n HT 40 MHz	5510 ~ 5710
		IEEE 802.11n HT ac20 MHz	5500 ~ 5720
		IEEE 802.11n HT ac40 MHz	5510 ~ 5710
		IEEE 802.11ac VHT 80 MHz	5530, 5610, 5690

Remark:

1. EUT pre-scanned data rate of output power for each mode, the worst data rate were recorded in this report.
2. The mode IEEE 802.11ac VHT20 and VHT40 are only different in control messages with IEEE 802.11n 20 MHz and HT40, and have same power setting. Therefore, the highest power(IEEE 802.11n 20 MHz and HT40) were test conducted and radiated measurement and recorded in this report.
3. For Canada the EUT Frequency Range 5600~5720MHz will be disabled.

4. TEST RESULT

4.1 TEST LIMIT

FCC according to §15.407 (h), KDB 905462 D02 "compliance measurement procedures for unlicensed-national information infrastructure devices operating in the 5250-5350 MHz and 5470-5725 MHz bands incorporating dynamic frequency selection". and KDB 905462 D03 " U-NII client devices without radar detection capability.

IC according RSS-247 section 6.3, and it harmonized with FCC Part 15 DFS rules.

The EIRP refer section 4.3 output power measurement in this report.

Table 1: Applicability of DFS requirements prior to use of a channel

Requirement	Operational Mode		
	Master	Client (without radar detection)	Client(with radar detection)
Non-Occupancy Period	Yes	Not required	Yes
DFS Detection Threshold	Yes	Not required	Yes
Channel Availability Check Time	Yes	Not required	Not required
U-NII Detection Bandwidth	Yes	Not required	Yes

Table 2: Applicability of DFS requirements during normal operation

Requirement	Operational Mode	
	Master Device or Client with Radar Detection	Client Without Radar Detection
DFS Detection Threshold	Yes	Not required
Channel Closing Transmission Time	Yes	Yes
Channel Move Time	Yes	Yes
U-NII Detection Bandwidth	Yes	Not required

Additional requirements for devices with multiple bandwidth mods	Master Device or Client with Radar Detection	Client Without Radar Detection
U-NII Detection Bandwidth and Statistical Performance Check	All BW modes must be tested	Not required
Channel Move Time and Channel Closing Transmission Time	Test using widest BW mode available	Test using the widest BW mode available for the link
All other tests	Any single BW mode	Not required
Note: Frequencies selected for statistical performance check (Section 7.8.4) should include several frequencies within the radar detection bandwidth and frequencies near the edge of the radar detection bandwidth. For 802.11 devices it is suggested to select frequencies in each of the bonded 20 MHz channels and the channel center frequency.		

Table 3: Interference Threshold values, Master or Client incorporating In-Service

Maximum Transmit Power	Value (See Notes 1, 2, and 3)
EIRP $\geq$ 200 milliwatt	-64 dBm
EIRP < 200 milliwatt and power spectral density < 10 dBm/MHz	-62 dBm
EIRP < 200 milliwatt that do not meet the power spectral density requirement	-64 dBm

Note 1: This is the level at the input of the receiver assuming a 0 dBi receive antenna.

Note 2: Throughout these test procedures an additional 1 dB has been added to the amplitude of the test transmission waveforms to account for variations in measurement equipment. This will ensure that the test signal is at or above the detection threshold level to trigger a DFS response.

Note3: EIRP is based on the highest antenna gain. For MIMO devices refer to KDB Publication 662911 D01.

Table 4: DFS Response requirement values

Parameter	Value
Non-occupancy period	Minimum 30 minutes
Channel Availability Check Time	60 seconds
Channel Move Time	10 seconds See Note 1.
Channel Closing Transmission Time	200 milliseconds + an aggregate of 60 milliseconds over remaining 10 second period. See Notes 1 and 2.
U-NII Detection Bandwidth	Minimum 100% of the U-NII 99% transmission power bandwidth. See Note 3.

Note 1: Channel Move Time and the Channel Closing Transmission Time should be performed with Radar Type 0. The measurement timing begins at the end of the Radar Type 0 burst.

Note 2: The Channel Closing Transmission Time is comprised of 200 milliseconds starting at the beginning of the Channel Move Time plus any additional intermittent control signals required to facilitate a Channel move (an aggregate of 60 milliseconds) during the remainder of the 10 second period. The aggregate duration of control signals will not count quiet periods in between transmissions.

Note 3: During the U-NII Detection Bandwidth detection test, radar type 0 should be used. For each frequency step the minimum percentage of detection is 90 percent. Measurements are performed with no data traffic.

Table 5 – Short Pulse Radar Test Waveforms

Radar Type	Pulse Width (μsec)	PRI (μsec)	Number of Pulses	Minimum Percentage of Successful Detection	Minimum Number of Trials
0	1	1428	18	See Note 1	
1	1	Test A: 15 unique PRI values randomly selected from the list of 23 PRI values in Table 5a	Roundup $\left\{ \left(\frac{1}{360} \right) \cdot \left(\frac{19 \cdot 10^6}{\text{PRI}_{\mu\text{sec}}} \right) \right\}$	60%	30
		Test B: 15 unique PRI values randomly selected within the range of 518-3066 μsec, with a minimum increment of 1 μsec, excluding PRI values selected in Test A			
2	1-5	150-230	23-29	60%	30
3	6-10	200-500	16-18	60%	30
4	11-20	200-500	12-16	60%	30
Aggregate (Radar Types 1-4)				80%	120
Note 1: Short Pulse Radar Type 0 should be used for the detection bandwidth test, channel move time, and channel closing time tests.					

Table 6 – Long Pulse Radar Test Signal

Radar Type	Pulse Width (μsec)	Chirp Width (MHz)	PRI (μsec)	Number of Pulses per Burst	Number of Bursts	Minimum Percentage of Successful Detection	Minimum Number of Trials
5	50-100	5-20	1000-2000	1-3	8-20	80%	30

Table 7 – Frequency Hopping Radar Test Signal

Radar Type	Pulse Width (μsec)	PRI (μsec)	Pulses per Hop	Hopping Rate (kHz)	Hopping Sequence Length (msec)	Minimum Percentage of Successful Detection	Minimum Number of Trials
6	1	333	9	0.333	300	70%	30

4.2 TEST PROCEDURE

Overview Of EUT With Respect To §15.407 (H) Requirements

The firmware installed in the EUT during testing was:

Firmware Rev: 1030.25.701.2017

The EUT operates over the 5250-5350 MHz range as a Client Device that does not have radar detection capability.

The EUT uses one transmitter connected to two 50-ohm coaxial antenna ports via a diversity switch. Only one antenna port is connected to the test system since the EUT has one antenna only.

The Slave device associated with the EUT during these tests does not have radar detection capability.

WLAN traffic is generated by streaming the video file TestFile.mp2 “6 ½ Magic Hours” from the Master to the Slave in full motion video mode using the media player with the V2.61 Codec package.

The EUT utilizes the 802.11a architecture, with a nominal channel bandwidth of 20 MHz.

The rated output power of the Master unit is < 23dBm (EIRP). Therefore the required interference threshold level is -62 dBm. After correction for antenna gain and procedural adjustments, the required conducted threshold at the antenna port is $-62 + 5 = -57\text{dBm}$.

The calibrated conducted DFS Detection Threshold level is set to -57 dBm. The tested level is lower than the required level hence it provides margin to the limit.

Manufacturer's Statement Regarding Uniform Channel Spreading

The end product implements an automatic channel selection feature at startup such that operation commences on channels distributed across the entire set of allowed 5GHz channels. This feature will ensure uniform spreading is achieved while avoiding non-allowed channels due to prior radar events.

TEST AND MEASUREMENT SYSTEM

System Overview

The measurement system is based on a conducted test method.

The short pulse and long pulse signal generating system utilizes the NTIA software. The Vector Signal Generator has been validated by the NTIA. The hopping signal generating system utilizes the CCS simulated hopping method and system, which has been validated by the DoD, FCC and NTIA. The software selects waveform parameters from within the bounds of the signal type on a random basis using uniform distribution.

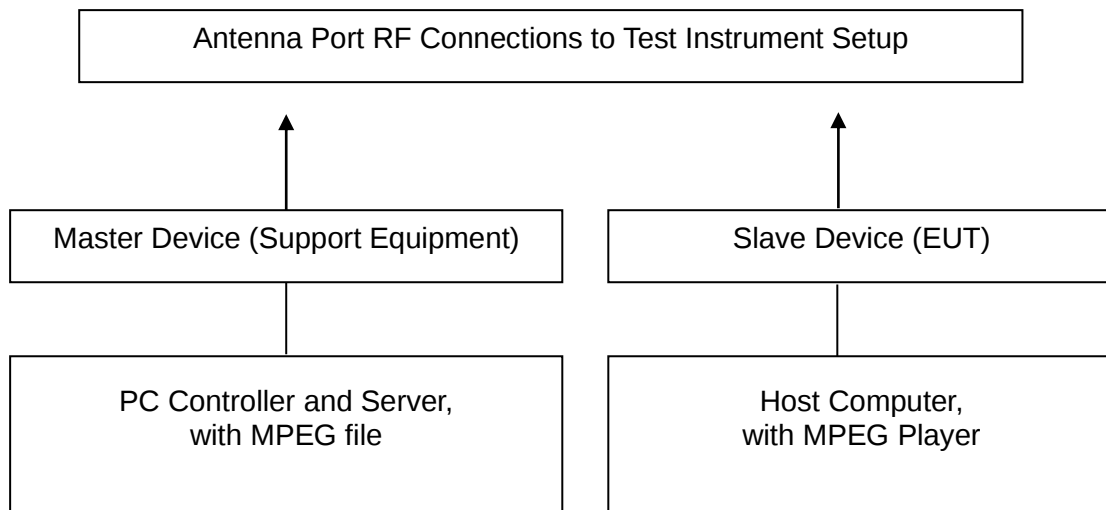
The short pulse types 2, 3 and 4, and the long pulse type 5 parameters are randomized at run-time.

The hopping type 6 pulse parameters are fixed while the hopping sequence is based on the August 2005 NTIA Hopping Frequency List. The initial starting point randomized at run-time and each subsequent starting point is incremented by 475. Each frequency in the 100-length segment is compared to the boundaries of the EUT Detection Bandwidth and the software creates a hopping burst pattern in accordance with Section 7.4.1.3 Method #2 Simulated Frequency Hopping Radar Waveform Generating Subsystem of FCC 06-96 APPENDIX. The frequency of the signal generator is incremented in 1 MHz steps from FL to FH for each successive trial. This incremental sequence is repeated as required to generate a minimum of 30 total trials and to maintain a uniform frequency distribution over the entire Detection Bandwidth.

The signal monitoring equipment consists of a spectrum analyzer set to display 8001 bins on the horizontal axis. The time-domain resolution is 2 msec / bin with a 16 second sweep time, meeting the 10 second short pulse reporting criteria. The aggregate ON time is calculated by multiplying the number of bins above a threshold during a particular observation period by the dwell time per bin, with the analyzer set to peak detection and max hold. The time-domain resolution is 3 msec / bin with a 24 second sweep time, meeting the 22 second long pulse reporting criteria and allowing a minimum of 10 seconds after the end of the long pulse waveform.

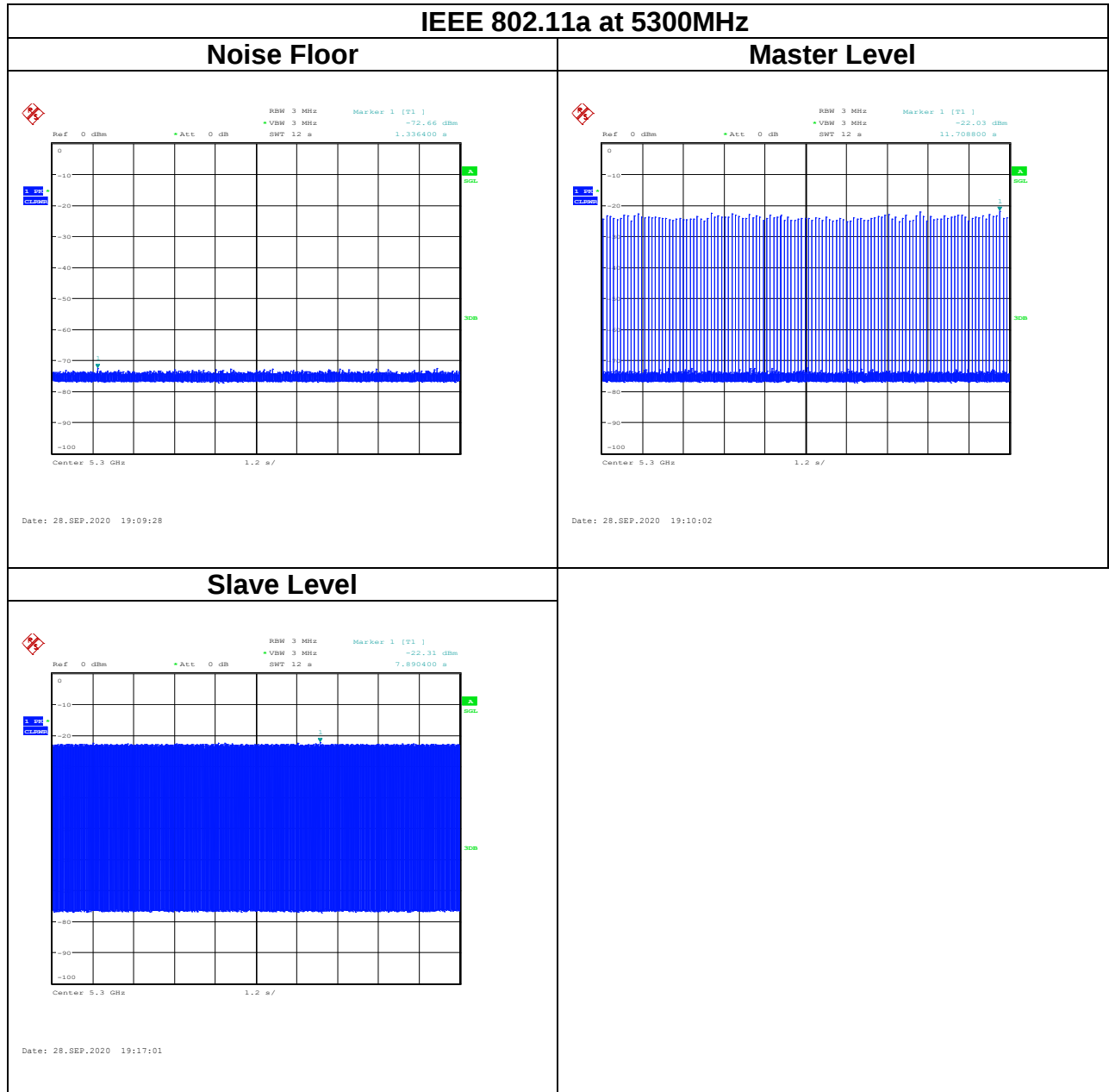
Should multiple RF ports be utilized for the Master and/or Slave devices (for example, for diversity or MIMO implementations), 50 ohm termination would be removed from the splitter so that connection can be established between splitter and the Master and/or Slave devices.

4.3 TEST SETUP



4.3.1 Test Result

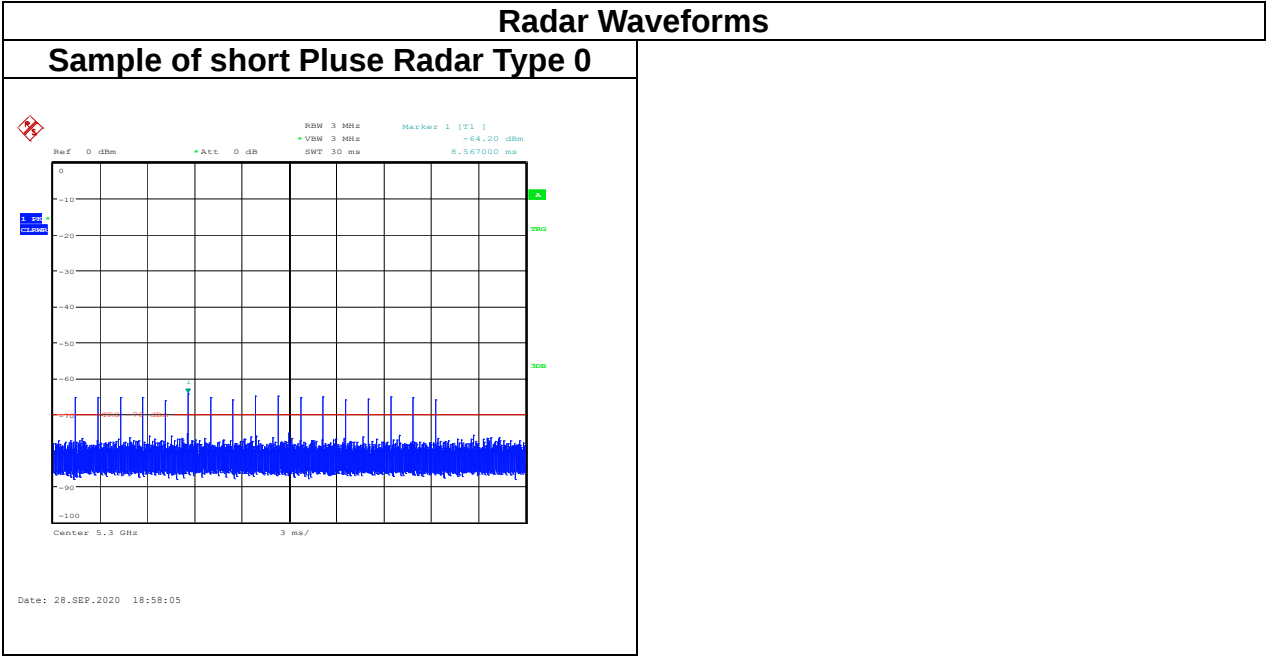
U-NII-2a





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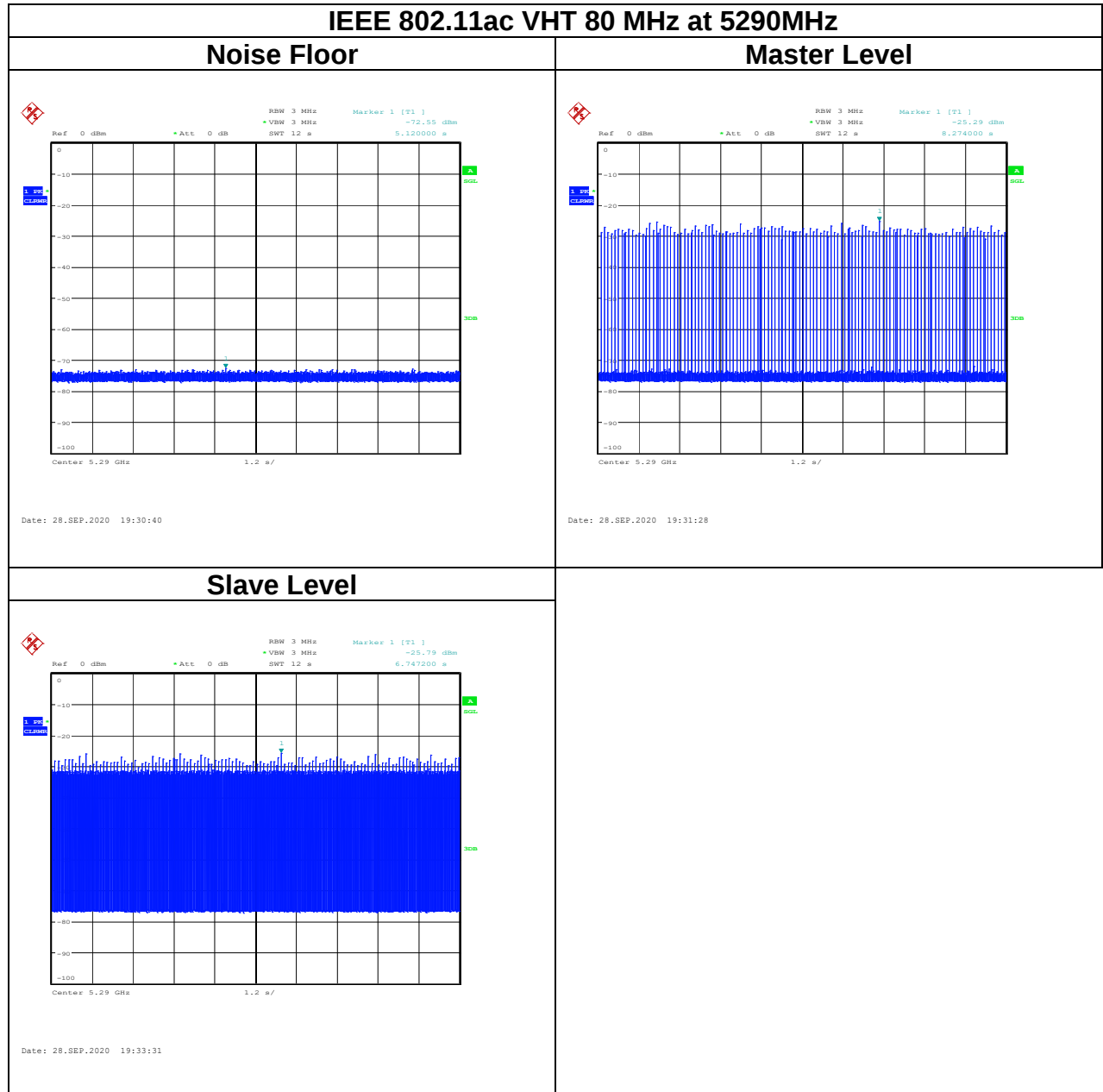
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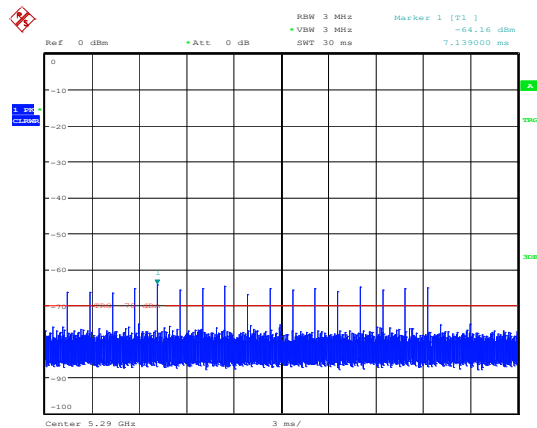
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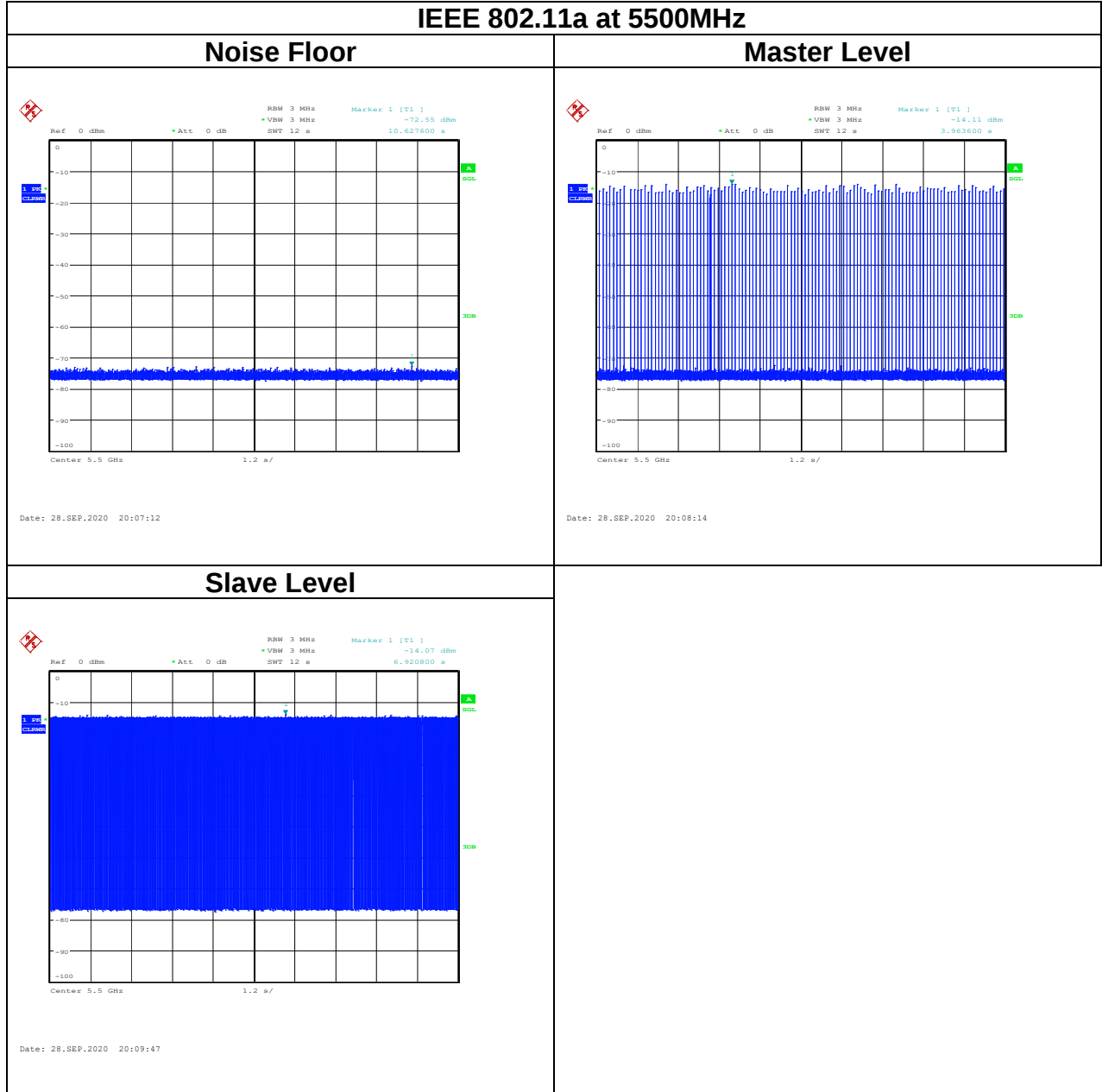
Radar Waveforms

Sample of short Pluse Radar Type 0



Date: 28.SEP.2020 18:57:32

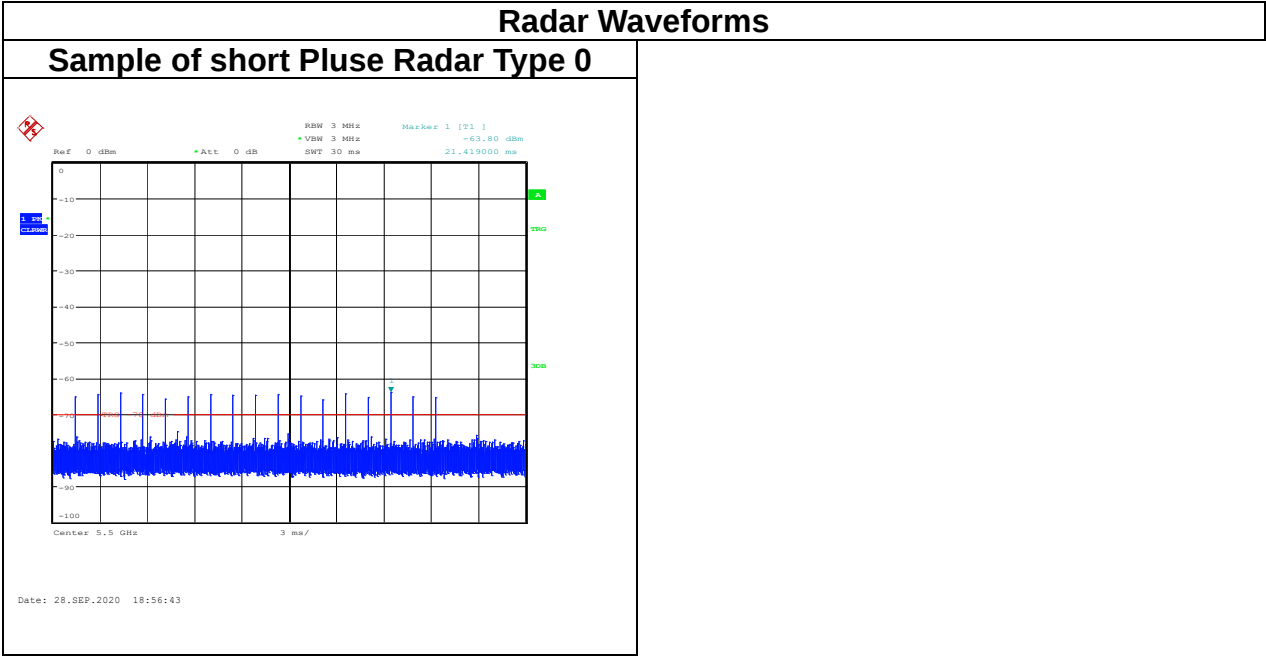
U-NII-2c

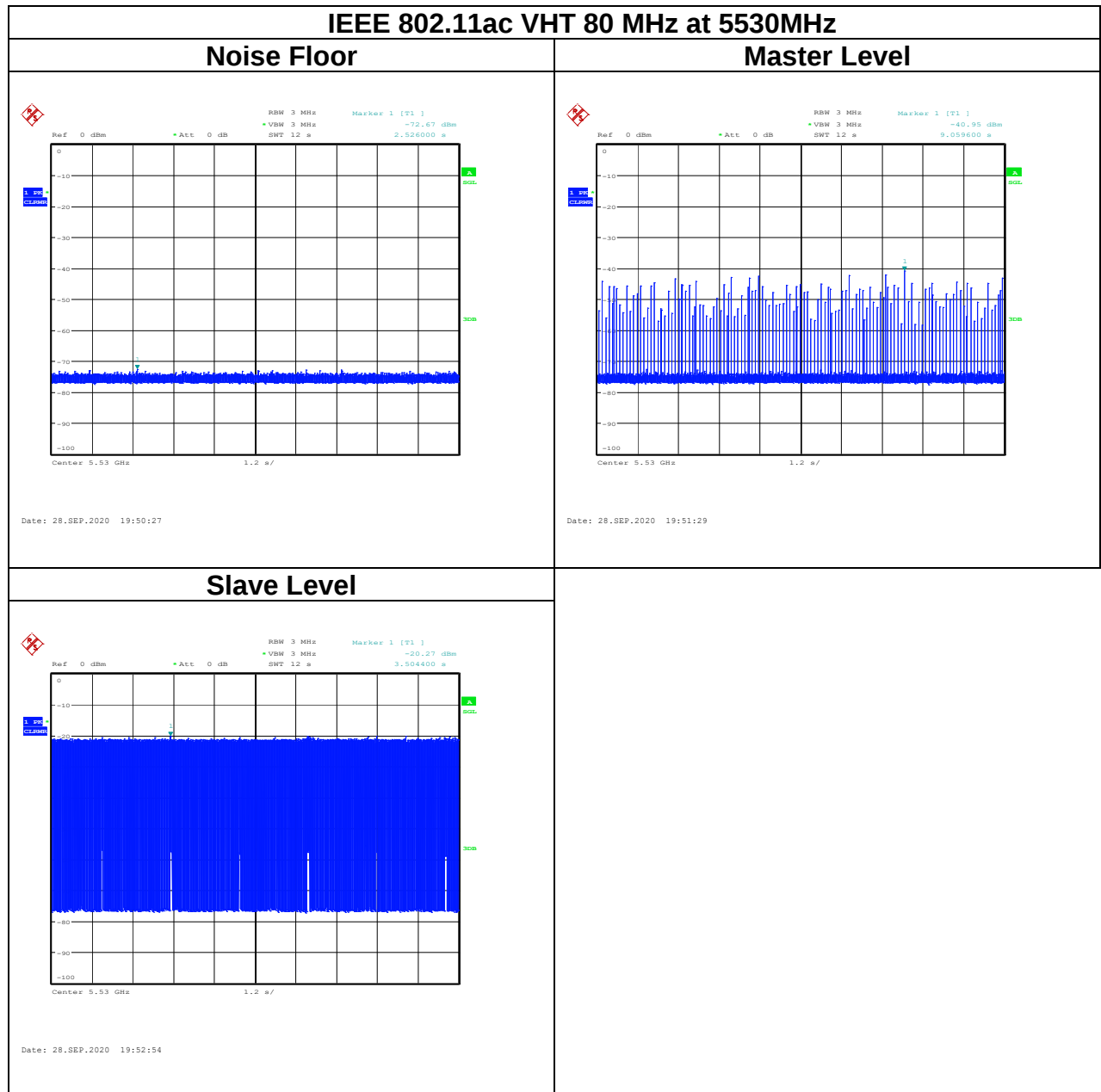




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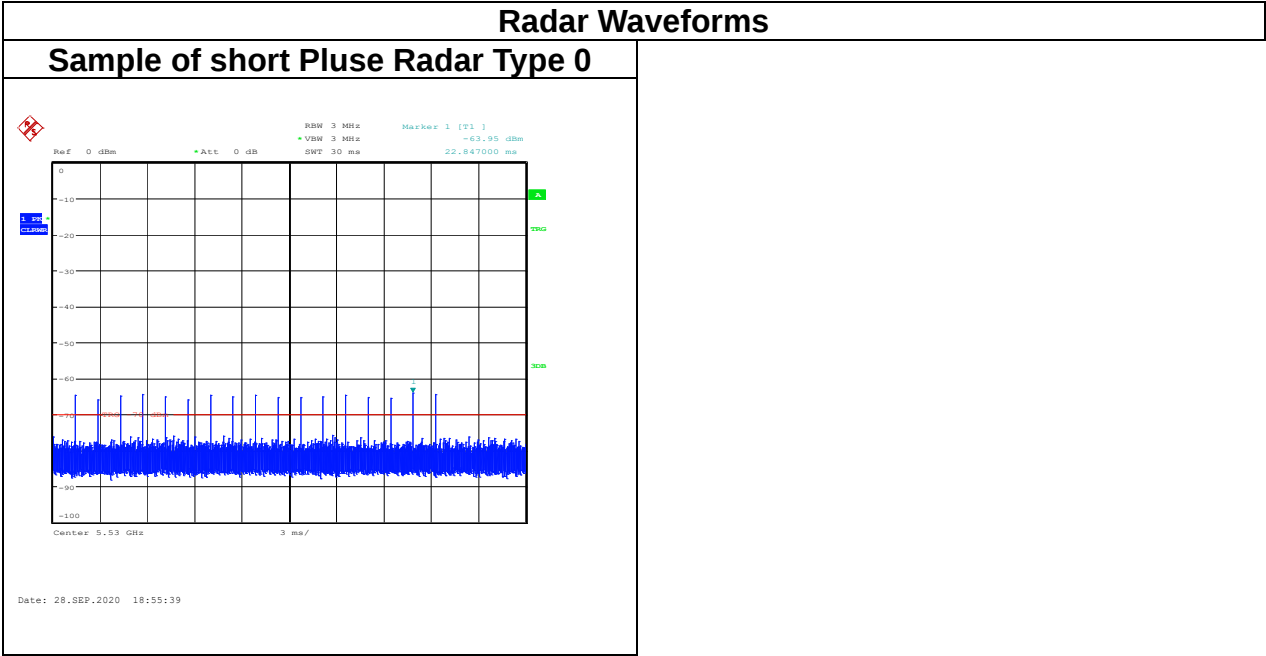






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TEST CHANNEL AND METHOD

All tests were performed at a channel center frequency of 5290 MHz 、 5300 MHz 、 5500 MHz and 5530 MHz utilizing a conducted test method.

CHANNEL MOVE TIME AND CHANNEL CLOSING TRANSMISSION TIME

GENERAL REPORTING NOTES

The reference marker is set at the end of last radar pulse.

The delta marker is set at the end of the last WLAN transmission following the radar pulse. This delta is the channel move time.

The aggregate channel closing transmission time is calculated as follows:

Aggregate Transmission Time =

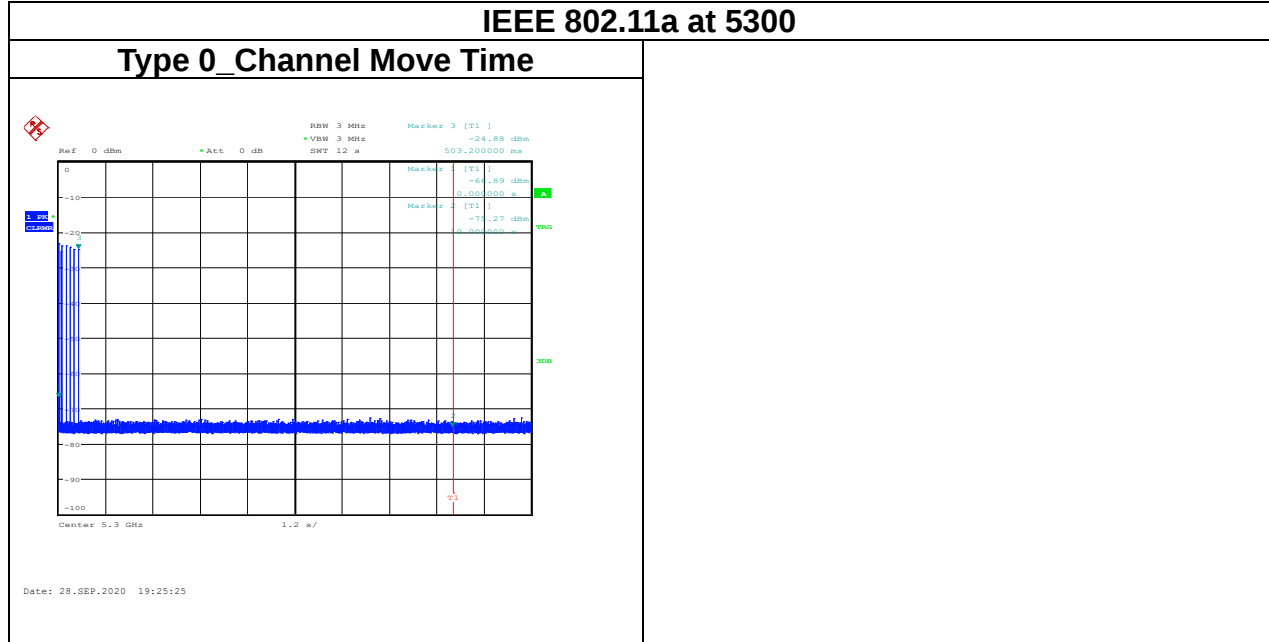
(Number of analyzer bins showing transmission) * (dwell time per bin)

The observation period over which the aggregate time is calculated

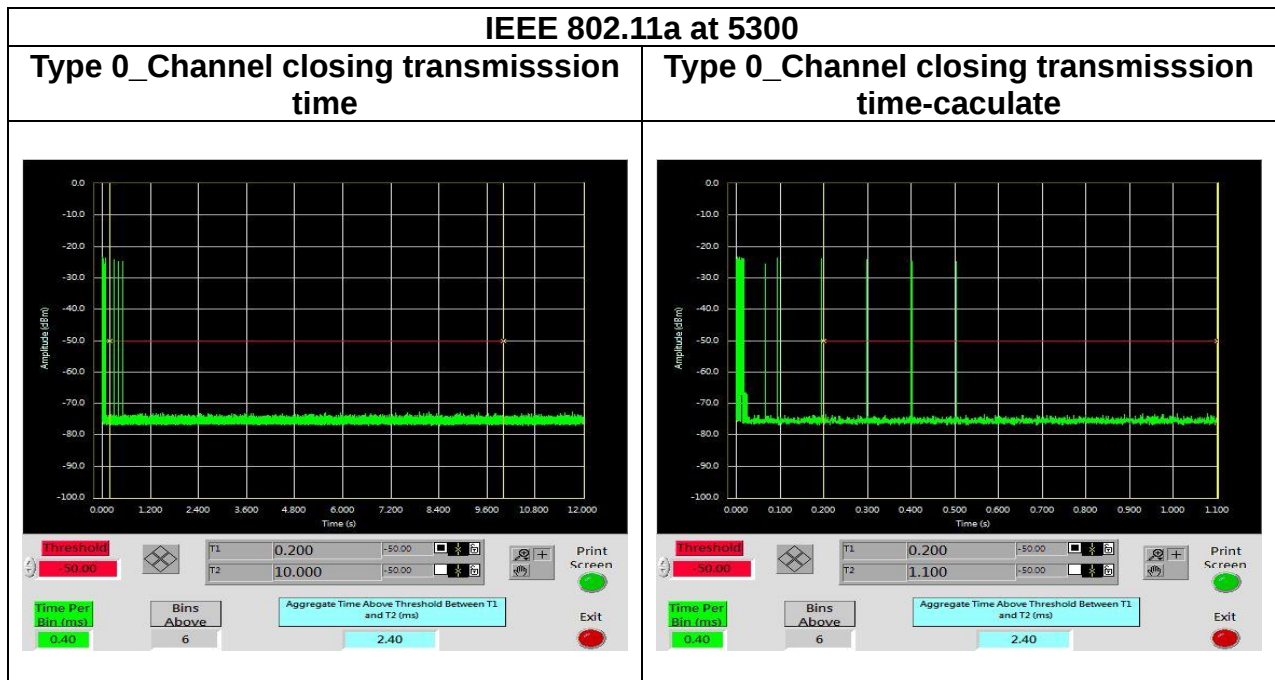
Begins at (Reference Marker + 200 msec) and

Ends no earlier than (Reference Marker + 10 sec).

U-NII-2a



Channel Move Time (s)	Limit (s)
0.5032	10

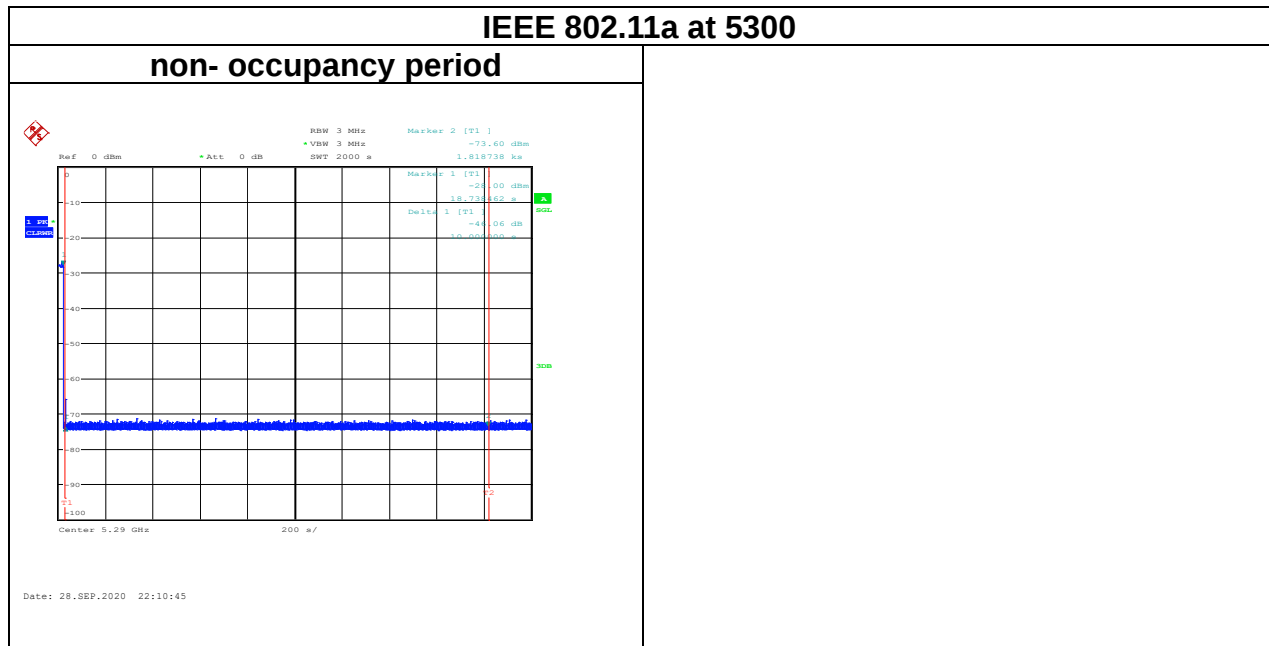


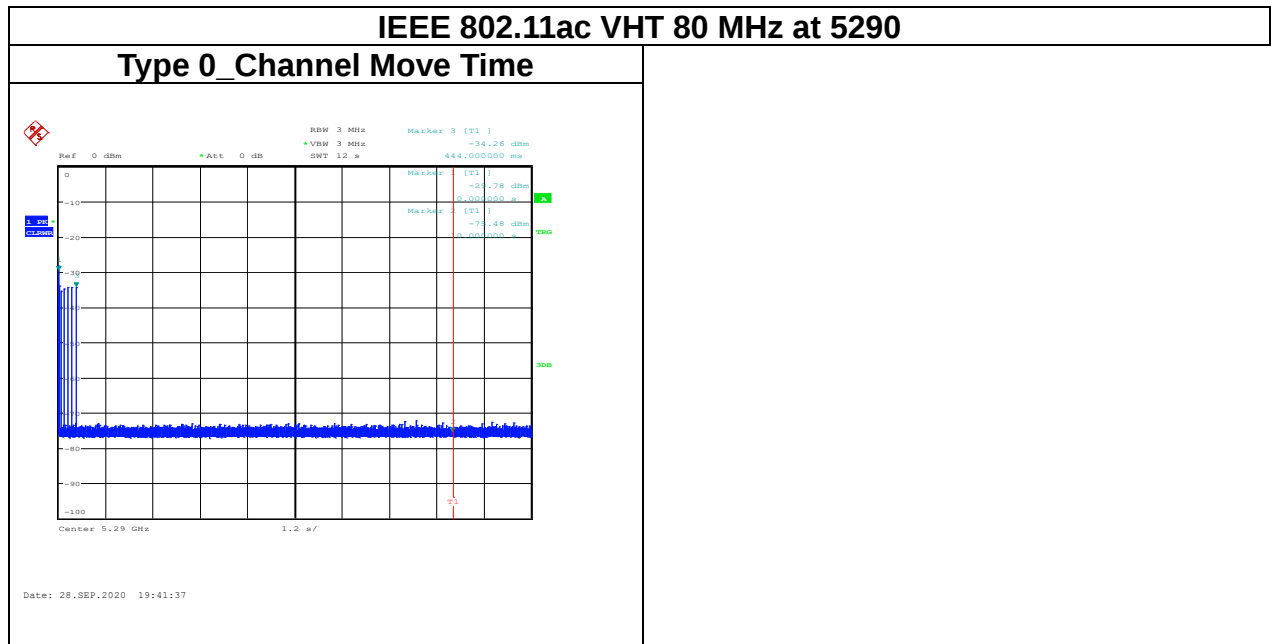
Aggregate Transmission Time (ms)	Limit (ms)	Margin (ms)
2.4	60	-57.6



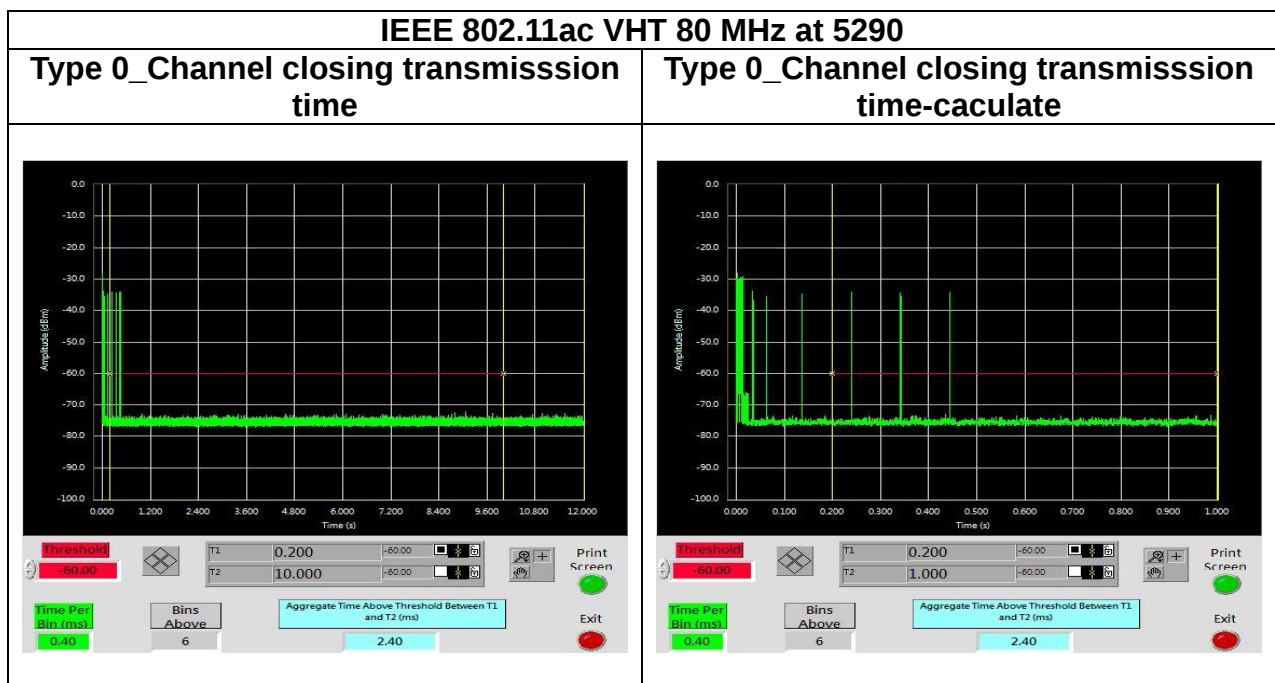
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Channel Move Time (s)	Limit (s)
0.4440	10

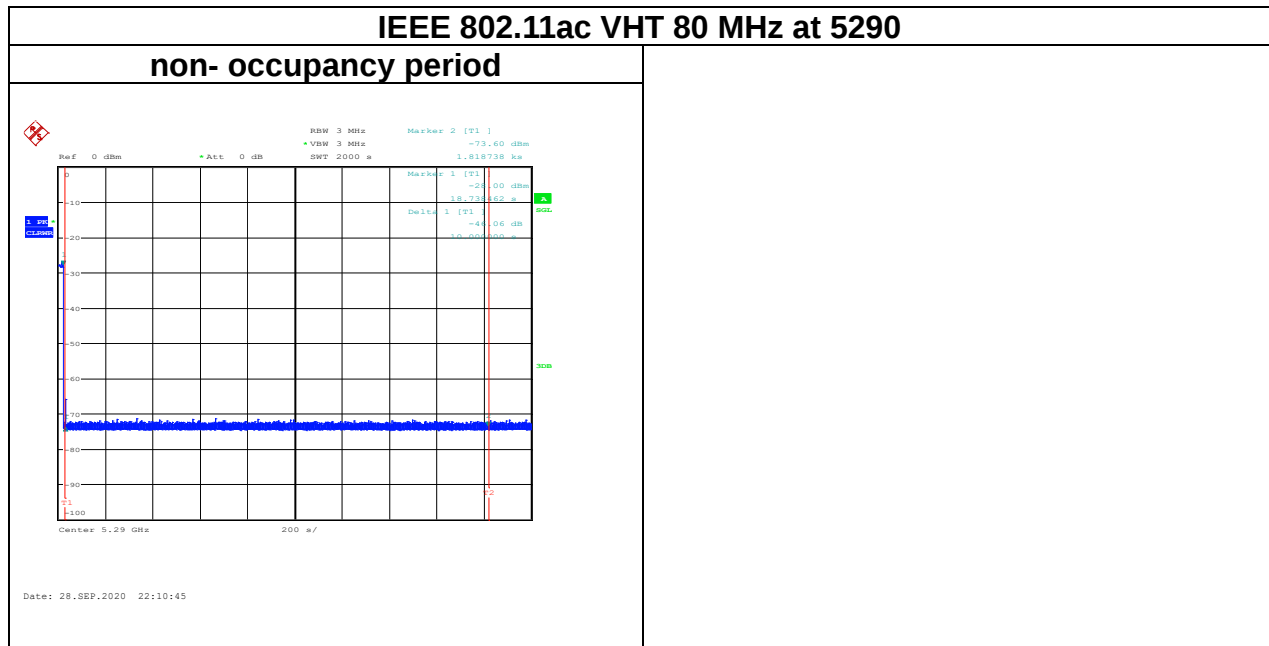


Aggregate Transmission Time (ms)	Limit (ms)	Margin (ms)
2.4	60	-57.6

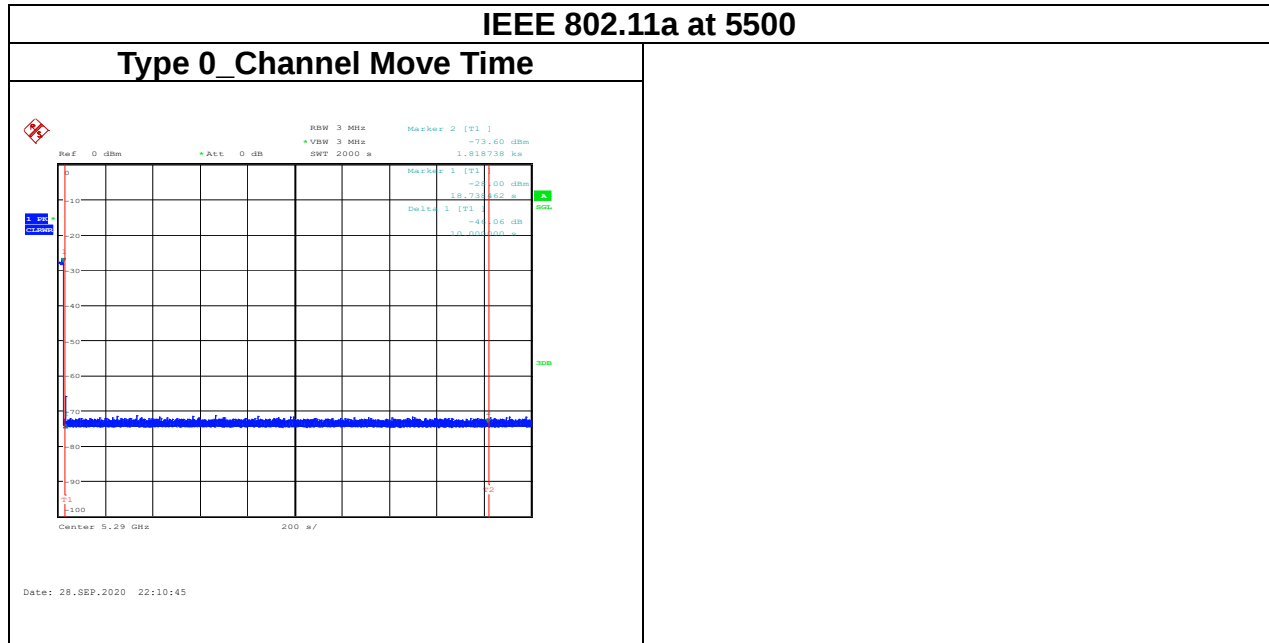


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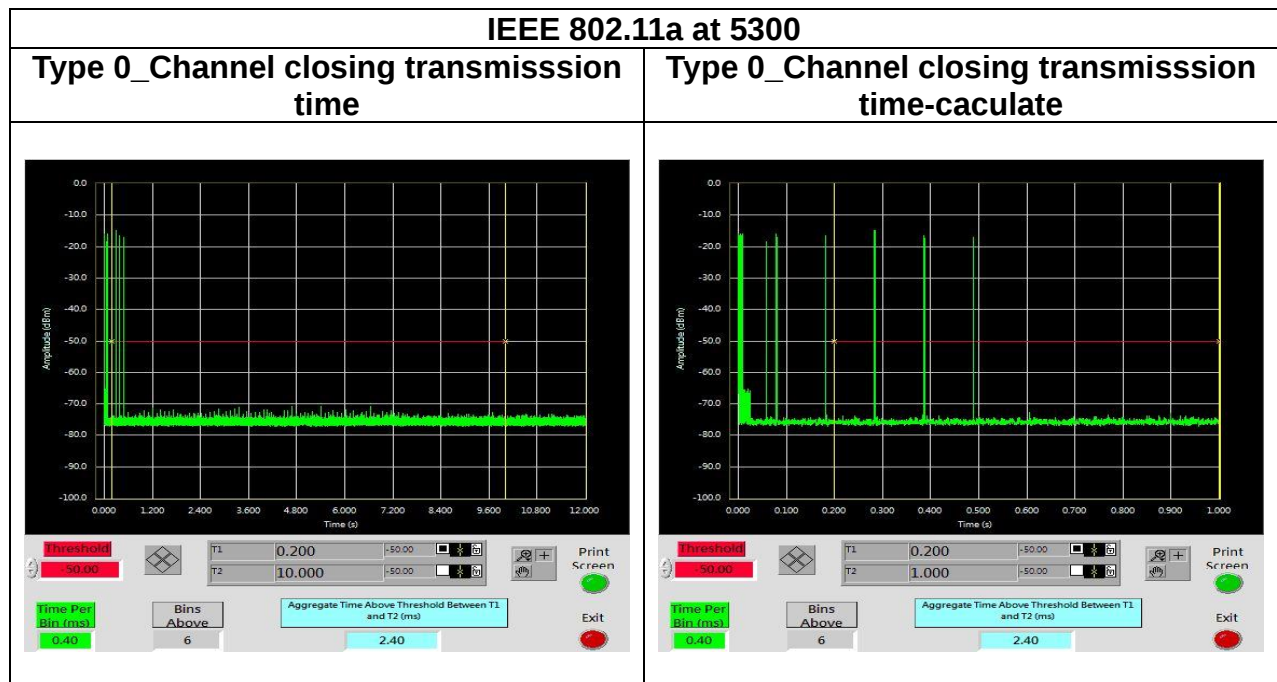
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U-NII-2c



Channel Move Time (s)	Limit (s)
1.8187	10

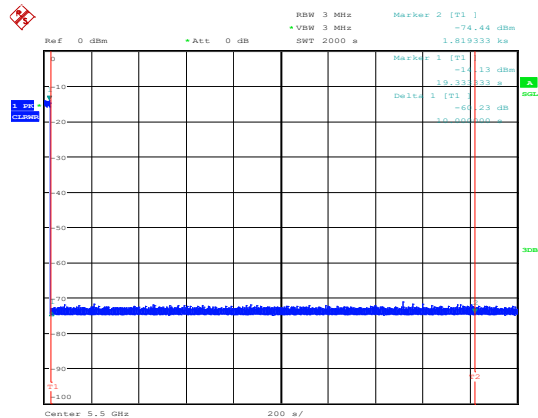


Aggregate Transmission Time (ms)	Limit (ms)	Margin (ms)
2.4	60	-57.6

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IEEE 802.11a at 5500

non- occupancy period

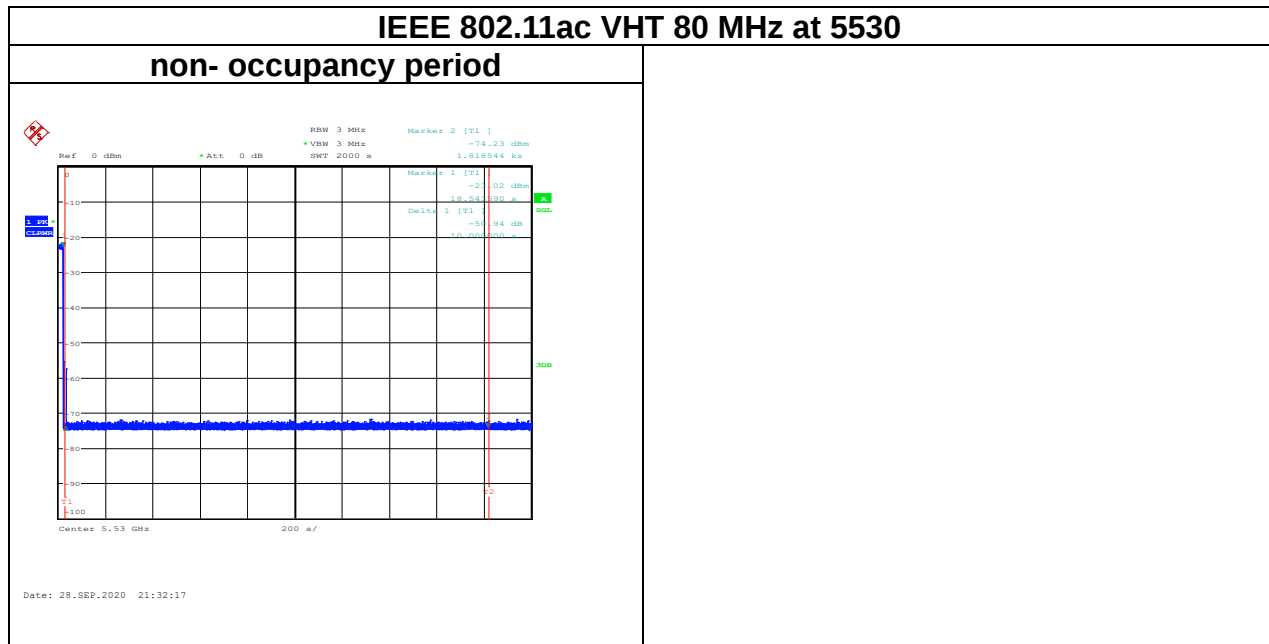


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--End of Test Report--

APPENDIX-A TEST PHOTO

DFS Set up Photos

